TERRA Transportation Engineering and Road Research Alliance
Partnering for Roadway Innovation
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Implementation of New Technologies

Throughout MnROAD's first decade of operation, the facility's engineers have introduced, developed, and encouraged the use of new technologies and techniques. This fact sheet highlights three technologies: Intelligent Compaction (IC), the Dynamic Cone Penetrometer (DCP), and Ground Penetrating Radar (GPR).

1 Intelligent Compaction

Intelligent compaction (IC), also known as continuous compaction control, is a quality-control system used in pavement construction to continuously monitor the stiffness of materials. The stiffness data can be linked to machine controls, which then adjust the compaction accordingly to avoid over- or under-compaction.

Research Highlights

- MnROAD engineers found that intelligent compactors do an excellent job of ensuring **uniformity in compaction** by providing the roller operator immediate feedback that quantifies the quality of their work, allowing them to make better decisions.
- IC is beginning to replace sand-cone testing. Newer mechanistic tests (such as DCP) are far better suited for **quality assurance** in conjunction with IC. Moreover, mechanistic tests can be conducted in a fraction of the time required for sand cones and with much greater jobsite safety.
- MnROAD experience has contributed to work plan development for IC in **NCHRP 21-09**, a federally funded project to determine the reliability of IC equipment and develop construction specifications for projects involving IC. Mn/DOT is also lending its MnROAD-derived experience to an FHWA-led IC pooled-fund study.

Implementation

These recent projects in Minnesota used intelligent compaction rollers:

- Reconstruction of T.H. 64 near Akeley (2006)
- Reconstruction of the I-494/Valley Creek Road interchange in Woodbury (2006)
- Expansion of U.S. 10 in Staples (2007)
- Realignment of U.S. 10 in Detroit Lakes (2007)
- Reconstruction of T.H. 60 near Worthington (2007)
- Reconstruction of T.H. 36 through North St. Paul (2007)

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2 Dynamic Cone Penetrometer

The Dynamic Cone Penetrometer (DCP) is a simple testing device used to measure the in situ shear strength of soil and granular materials used in roadways and other construction projects. Data from a DCP test are processed to produce a DCP penetration index (DPI), the distance the cone penetrates with each drop of the hammer. MnROAD testing and experience contributed to the development of an automated DCP (ADCP).

Research Highlights

- Extensive DCP testing and research at MnROAD and dozens of construction project sites in Minnesota have improved DCP performance and applications.
- MnROAD efforts with the DCP have influenced **Mn/DOT specifications** and its assessment of subgrades and pavement systems during construction.
- A wealth of **DCP testing data** accumulated in the MnROAD database serves as a resource for the use and further development of the DCP.
- MnROAD's continued work in refining the application of the DCP in the field prompted Mn/DOT to investigate and eventually adopt the use of the DCP to evaluate the **uniformity of compaction** of pavement edge drain trenches, aggregate base layers, and granular sub-base layers.
- Physical modifications made to improve the **usability and safety** of the device itself have become standard on the DCP as used by Mn/DOT.

Implementation

- Mn/DOT currently specifies two applications of DCP testing in its pavement assessment procedure.
- Other nonspecified applications of the DCP have included:
  - investigations of soft sub-cut areas
  - determination of the condition of base and subgrade materials under full-depth bituminous cracks
  - monitoring of the effectiveness of subgrade fly ash stabilization

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3 Ground-Penetrating Radar

Ground Penetrating Radar (GPR) is a high-speed, continuous, nondestructive field test used to assess the subsurface conditions of a pavement in the field. GPR consists of a transmitter to create a pulse of electromagnetic energy into the ground, an antenna to detect the reflected pulses, and a data collection system to monitor the arrival times and amplitudes of the reflected pulses. Subsequent analysis of the collected data is used to determine layer depths and locate underground anomalies.

Research Highlights

- GPR can be used effectively up to highway speed to evaluate pavement profile and determine **asphalt pavement thickness**, which can minimize the number of cores taken from the pavement, as well as increase safety and reduce cost.
- Mn/DOT has expanded the use of GPR as a **nondestructive method** of assessing a given situation beyond pavements to profile subsurface anomalies in various materials and locate underground utilities.
- MnROAD is used to calibrate some of the **state-of-the-art GPR equipment** maintained by Mn/DOT, which includes a data collection system and five antennas.
- As GPR experience grows at Mn/DOT, **data collection and analysis methods** are being clarified and standardized. Statewide presentations were made in 2007 to district and local engineers to promote the use of GRP for pavement evaluations.

Implementation

- Mn/DOT has used GPR successfully for determining asphalt pavement thickness profiles and locating underground anomalies. GPR also has been used with moderate success to identify potential stripping in asphalt layers.
- These recent projects in Minnesota used GPR:
  - Lake Street (City of Minneapolis), subsurface voids detection
  - T.H. 65 (McGregor), bituminous asphalt layer-thickness study
  - I-35W (Minneapolis), asphalt shoulder layer-thickness study

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Partners

- Minnesota Local Road Research Board (LRRB)
- Federal Highway Administration (FHWA)
- Transportation Research Board (TRB)
- Strategic Highway Research Program (SHRP)
- University of Minnesota
- Iowa State University
- Industry representatives, including contractors and material providers

About TERRA

The Transportation Engineering and Road Research Alliance, or TERRA, brings together government, industry, and academia in a dynamic partnership to advance innovations in road engineering and construction, including issues related to cold climates. More about TERRA is online at **www.TerraRoadAlliance.org**.

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For Further Reading

- *MnROAD Lessons Learned* (Mn/DOT Report MN-RC-2007-06)
- Dynamic Cone Penetrometer Implementation in Minnesota
- Accelerated Implementation of Intelligent Compaction Technology for Embankment Subgrade Soils, Aggregate Base and Asphalt Pavement Material (Transportation Pooled Fund Program #954)
- *Implementation of Ground Penetrating Radar* (Mn/DOT Report MN-RC-2007-34)
- *Field Validation of Intelligent Compaction Monitoring Technology for Unbound Materials* (Mn/DOT Report MN-RC-2007-10)
- Performance Specifications and Intelligent Compaction Implementation (Mn/DOT presentation, January 2007)
- Intelligent Compaction: A Minnesota Case History (Mn/DOT conference paper, 2005)
- Intelligent Compaction Pooled-Fund Web Site
- Pavement Interactive DCP and LWD User Group Web Site

Links to these publications are on the TERRA Web site at www.TerraRoadAlliance.org